CONTROLLING the JAPANESE BEETLE

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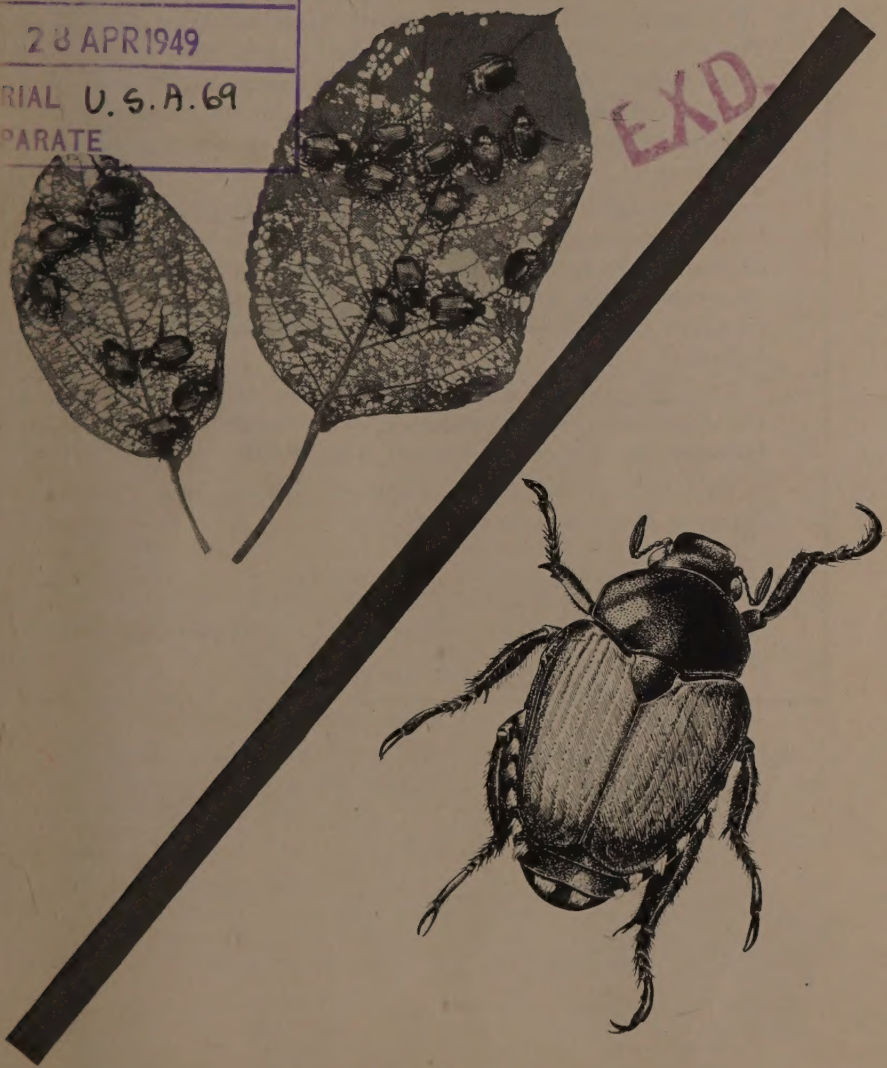

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THE JAPANESE BEETLE has plagued farmers and home owners in many eastern States in recent years. The beetles feed on nearly 275 kinds of trees, shrubs, and other plants, injuring many of them severely. In the grub stage the insect feeds in the ground on the roots of grasses and other plants, often ruining lawns, golf courses, and other turf areas.

The control of the Japanese beetle is a dual problem. The beetles can in most situations be dealt with best by spraying or dusting the trees, shrubs, or plants with DDT. Most of the grubs can be killed by treating the soil with the same material. Other methods of control are discussed in the bulletin.

This bulletin also summarizes available information on the distribution, seasonal history, and natural factors that influence the abundance of the Japanese beetle.

This bulletin supersedes Farmers' Bulletin 1856, The Japanese Beetle and Its Control.

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CONTROLLING THE JAPANESE BEETLE[1]

Prepared in the Division of Fruit Insect Investigations, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration.

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JAPANESE BEETLES have in recent years plagued farmers and home gardeners in many of the eastern States. For a month or two during the summer they chew up the leaves and other soft parts of nearly 275 kinds of trees, shrubs, and other plants. They also ruin roses and other flowers. If you live in the afflicted areas, you probably know the Japanese beetle when you see it in the summer. During the rest of the year the insect is less often seen, but you can find it in the ground as a white grub. (See plate 1, page 7.) There it feeds on the roots of grasses and other plants, often ruining turf in lawns, parks, and other areas.

The control of the Japanese beetle is a dual problem, for the methods applied to the beetles are not adaptable to use against the grubs.

CONTROL OF THE BEETLES

SPRAYING OR DUSTING

The beetles may be controlled best by spraying or dusting the plants with an insecticide. Several effective materials are available for use under different conditions.

DDT

The most effective material for killing beetles is DDT. It may be bought in many forms, but a wettable powder is the one most generally useful for Japanese beetle control. To make a spray mix a wettable powder containing 50 percent of actual DDT with water as follows:

To make—	*Quantity of powder required*
1 gallon	1½ tablespoonfuls
10 gallons	3 ounces
100 gallons	2 pounds

[1] *Popillia japonica* Newm.

If the powder contains only 25 percent of DDT, use twice the quantities given above. Follow the instructions on the label, if they do not agree exactly with those given above. Thoroughly mix the powder with the water, and stir or shake the mixture every few minutes while spraying. Do not use oil solutions of DDT such as those often sold for use against household insects, because they may injure the plants.

DDT may also be applied dry, in dust form. Use a dust containing 5 percent of DDT for this purpose. Lower strengths have less value. You must apply dusts more often than sprays. (See page 3.)

The use of DDT on plants is often followed by increases in the numbers of mites. It has little effect on the mites, but destroys their natural enemies. Be prepared to control the mites if necessary.

Lead Arsenate

Lead arsenate will also prevent injury by the Japanese beetle, but it drives off more beetles than it kills. To make a spray, mix dry lead arsenate and wheat flour with water as follows:

To make—	*Quantity required*	
	Lead arsenate	*Wheat flour*
1 gallon	3 tablespoonfuls	2½ tablespoonfuls
10 gallons	10 ounces	6 ounces
100 gallons	6 pounds	4 pounds

Mix the flour thoroughly with a little cold water to make a thin paste. Wash the dry lead arsenate directly into the sprayer and fill the tank about half full. Add the flour paste with constant stirring. Then add the rest of the water.

The flour in this spray sticks the poison to the leaves. When the spray is to be used on shade trees, some other sticker, such as raw linseed oil or fish oil, may be substituted for the flour. Four fluid ounces of the oil should be added to each pound of lead arsenate.

Caution.—**DDT and lead arsenate are poisonous to human beings and animals. Store them in plainly labeled containers where they cannot be mistaken for flour, baking powder, or other food products. Store them where children or pets cannot reach them. Do not inhale any of the spray or dust while applying it, or allow oil solutions of DDT to come into prolonged contact with the body. Keep DDT out of ponds; it kills some kinds of fish.**

When used as recommended, DDT is not likely to injure human beings, pets, or wildlife.

DDT or lead arsenate should not be used on small fruits, such as raspberry, blackberry, blueberry, huckleberry, and strawberry, until after the fruit has been picked, or on parts of vegetables that are to be eaten. Do not use DDT on other fruits, such as apple, pear, quince, plum, cherry, peach, and grape, later than 2 or 3 weeks before picking, or lead arsenate later than 1 month before picking.

Do not use lead arsenate on peaches, nectarines, or plums, which are injured by this material at the strength needed for beetle control.

Rotenone

Certain rotenone-bearing materials, such as ground derris or cube, are of considerable value in driving beetles away. These materials are practically nonpoisonous to human beings and domestic animals. You should use a material containing not less than 4 percent of rotenone and not less than 12 percent of total extractives. To make a spray, mix the materials with water as follows:

To make—	*Quantity of rotenone-bearing material*
1 gallon	3 tablespoonfuls
10 gallons	5 ounces
100 gallons	3 pounds

Lime

Dusting with hydrated lime, which can be obtained from local hardware and builders' supply stores, is of some value in keeping beetles off plants. It is especially useful on vegetables, where a poison might be objectionable. Apply every few days, since it washes or blows off readily.

Application of Sprays or Dusts

To protect fruit and shade trees and ornamental shrubbery from Japanese beetles, spray with DDT or lead arsenate, preferably DDT in most cases. On elms, especially Chinese elms, use lead arsenate in preference to the DDT wettable powder, which sometimes injures elm leaves. Start your spray program when the beetles first appear, before damage is done. If the spray cover becomes ineffective because of rains, or if new growth must be protected, spray again in 1 to 3 weeks.

If more convenient, put DDT on as a dust, although more frequent applications may be required. Substitute rotenone-containing materials where DDT and lead arsenate cannot be used. Apply them every 7 to 10 days; they are not effective for a longer time.

Remove prematurely ripening fruit from the trees and the ground. Their odor attracts beetles, which then attack sound fruit. Diseased and poorly nourished trees and plants are especially susceptible to beetle attack. Keep them in a healthy, vigorous condition by the proper use of fertilizers and other measures.

Protect sweet corn by dusting the tips of the ears, when the silk first shows, with fine hydrated lime or with 5-percent DDT dust. Make two more applications at intervals of 3 days. Use extreme care to apply the material at the proper time to the tips of the ears. Do not use DDT on fodder crops that are to be eaten by milk cows or by animals that are being fattened for slaughter.

HAND COLLECTION

Partial temporary relief from beetle damage may be obtained by collecting the beetles by hand. Jar or shake the shrubs, trees, or individual branches early in the morning, when it is cool and the beetles are quiet. Place sheets under the plant to catch the beetles as they fall, and drop them into a bucket containing water and a little kerosene. You should do this every day, since more beetles are continually flying in from the outside.

TRAPPING

Traps designed to catch Japanese beetles have been used for a number of years. Where the beetles are seriously abundant, however, traps may catch tremendous numbers without reducing appreciably the damage done. Therefore, do not expect too much from trapping unless most of your neighbors also trap. Even with a community trapping program, do not expect traps to give complete protection of favored food plants. Instead, control the beetles by spraying or dusting.

If you attempt partial control by trapping, use traps painted yellow; such traps will catch the largest number of beetles. For bait, use a mixture of 10 parts of geraniol and 1 part of eugenol. If geraniol is not available, substitute anethole for it.[2]

The United States Department of Agriculture has made extensive use of traps along the margins of the infested area and elsewhere, to obtain information on the distribution of the insect in connection with efforts to retard its spread to new areas. With this exception, the Department does not place traps on private property, nor does it have traps available for distribution to individuals or community groups.

DISBUDDING AND SCREENING

Do not expect sprays to give full protection to your flowers; they unfold too fast. When the beetles are the most abundant on your rosebushes, nip the buds and then spray the bushes to protect the leaves. When the beetles get scarce, let the bushes bloom again. From that time on they will have many blossoms of good quality, and will bloom later than if allowed to flower through midsummer. You can protect choice flowers by enclosing the bushes with cloth or wire netting on a wooden or metal frame. You should use more fungicide than usual on such bushes, since plant diseases are more prevalent when the bushes are enclosed.

UTILIZATION OF PLANTS NOT SUBJECT TO ATTACK

When you are planning new ornamental plantings or modifying established plantings, make more extensive use of trees, shrubs, or plants that are not preferred by the beetles. Although the Japanese beetle will feed on nearly 275 different plants, many of the more common trees and plants are fed upon sparingly or not at all. The list that follows will aid you in the selection of plants and trees that are not subject to feeding by Japanese beetles. Select kinds least likely to be seriously injured.

Plants subject to feeding by beetles[3]

Small fruits:
- Blackberry, leaves and fruit
- Blueberry and huckleberry, leaves and fruit
- Currant, red varieties
- *Grape, leaves and fruit of early ripening varieties
- *Raspberry, leaves and fruit
- Strawberry

Orchard fruits:
- *Apple, leaves and especially fruit of early ripening varieties
- *Cherry
- Nectarine, foliage and fruit
- Peach; injury severe on fruit of early ripening varieties and occasionally severe on leaves
- Plum, foliage and fruit
- Quince

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[2] For more detailed information on the use of traps, see U. S. Department of Agriculture Circular 594, The Use of Traps Against the Japanese Beetle.

[3] Plants marked with an asterisk (*) are especially attractive to the beetles.

Plants subject to feeding by beetles—Continued

Truck and garden crops:
- Asparagus
- Beans
- Rhubarb
- *Sweet corn, leaves, silk, and ear

Field crops:
- Alfalfa
- Clover
- *Field corn, leaves, silk, and ear
- *Soybean

Ornamental shrubs and vines:
- Barberry
- Butterflybush, flowers only
- Crapemyrtle, leaves and flowers
- Lespedeza
- Oriental flowering cherry
- *Rose, leaves, buds, and flowers
- *Shrub-althea, flowers
- *Virginia creeper

Ornamental garden plants:
- Canna
- *Dahlia, leaves and flowers
- *Hollyhock, leaves and flowers
- *Marshmallow
- Rosemallow, leaves and flowers
- Snapdragon, especially flowers of dark-colored varieties
- *Zinnia

Shade trees:
- *Elm
- *Horsechestnut
- *Linden
- *Lombardy poplar
- *Norway maple
- Pin oak
- Planetree or buttonwood
- White birch
- *Willow

Plants rarely fed upon by beetles

Small fruits:
- Dewberry
- Gooseberry

Orchard fruits: Pear

Truck and garden crops:
- Cabbage
- Carrot
- Cauliflower
- Eggplant
- Lettuce
- Onion
- Parsley
- Pea
- Potato
- Radish
- Spinach
- Squash
- Sweetpotato
- Tomato
- Turnip

Field crops:
- Barley
- Oats
- Rye
- Wheat

Ornamental shrubs and vines:
- Azalea (except deciduous varieties)
- Beautyberry
- Box
- Clematis
- Deutzia
- English ivy
- Euonymus
- Evergreens
- Forsythia
- Honeysuckle
- Hydrangea
- Lilac
- Mockorange
- Privet
- Rhododendron
- Snowberry
- Spirea
- Weigela
- Wisteria

Ornamental garden plants:
- Aquilegia or columbine
- Calendula
- Carnation
- Chrysanthemum
- Coreopsis
- Cosmos
- Four-o'clock
- Gladiolus
- Goldenglow
- Iris
- Larkspur
- Lily
- Nasturtium
- Pachysandra
- Pansy
- Peony
- Petunia
- Phlox
- Snapdragon (light-colored varieties)
- Sweet pea
- Tulip
- Violet

Shade trees:
- Ash
- Beech
- Carolina poplar
- Catalpa
- Dogwood
- Evergreens (except cypress)
- Locust
- Maples (except Norway and Japanese)
- Oaks (except pin and chestnut)
- Redbud
- Sweetgum
- Tupelo or sour gum
- White poplar

CONTROL OF THE GRUBS

BY INSECTICIDES

The grubs in turf land may be controlled by the use of DDT, chlordane, or lead arsenate. At present the lead arsenate treatment is much more costly than the other two, and it will therefore not be discussed in detail.

DDT

Apply a dust containing 10 percent of DDT to the ground at the rate of 6 pounds to 1000 square feet, or 250 pounds to the acre. This gives 25 pounds of actual DDT per acre, the rate needed for best results. Use a dust containing no adhesive. You can treat small areas by broadcasting the dust by hand, but a fertilizer distributor will save time in applying it to large areas. For hand application, thoroughly mix the DDT dust with several times its volume of sand, soil, or other suitable material, which will aid in evenly distributing the dust. If the material is applied as a spray, use 1 ounce of actual DDT (2 ounces of 50-percent or 4 ounces of 25-percent wettable DDT powder) in 2½ gallons of water for each 100 square feet. Wash the material in, either the dust or spray, by sprinkling the lawn, unless rain can be expected within a few days. Keep children from playing and domestic animals from feeding on the grass until the insecticide has been washed in. One DDT treatment will last at least 5 years.

Chlordane

Use chlordane where grubs are causing severe turf injury and quick action is needed. It kills the grubs faster then either DDT or lead arsenate. Use 10 pounds of actual chlordane per acre, in a dust or spray. If you prefer a dust, apply 100 pounds of a 10-percent chlordane dust to each acre of turf, or 2¼ pounds to each 1,000 square feet, in the manner suggested for DDT. Double these amounts if you use a 5-percent dust. If you spray, use ¾ ounce of a 50-percent chlordane wettable powder (or 1 ounce of 40-percent material) in 2½ gallons of water for each 100 square feet. Observe the precautions outlined for DDT. You may expect a chlordane treatment to last at least 2 years.

Suggestions for Soil Treatment

Apply the insecticide to the turf at any time when the ground is not frozen, preferably in the spring. Put it on before damage has been done, if the beetle population is building up in your locality. After the insecticide has been applied, mow, water, and fertilize the lawn as usual.

If flower beds and gardens become seriously infested with grubs, you should apply DDT dust or spray as suggested for turf land, and then mix it with the upper 3 or 4 inches of soil. Do not apply DDT to gardens unless necessary, however, since a few kinds of plants do not grow well in soil given this treatment. Do not use any of these insecticides on pastures.

Adult beetles feeding on fruit and leaves, about one-half natural size. Insert, adult beetle, about twice natural size. Figures below ground represent seasonal history of the Japanese beetle. Left to right, mature grub (late spring); pupa; beetle laying eggs (summer); developing grubs (late summer and fall); all about twice natural size.

PLATE 1

Figure 1.—Applying lead arsenate mixture with a small fertilizer distributor for grubproofing turf.

USE OF MILKY DISEASE

Diseases of the grubs are discussed in some detail on page 13. Dust material containing spores of the milky disease is available from commercial sources. You can use it to advantage in reducing the grub population on your premises. Follow the directions on the package. Apply milky disease any time when the ground is not frozen. Do not expect immediate results, as it may be several years before the milky disease treatment becomes fully effective.

COMMUNITY EFFORT

Community effort is important in the effective control of the Japanese beetle. The work that you do to kill the grubs in your own yard will not prevent beetles that breed in untreated areas nearby from flying in to injure your shrubbery during the summer. Likewise, the efforts you alone make to protect your plants and control the beetles in any one year may not affect the numbers of beetles that are present in following years. A general reduction is possible only if control measures are extensively applied, except in years when weather conditions are unfavorable to the development of beetles or when other natural controls take hold. Organize your neighbors, or your community, into a control district. Consult your State and county officials to determine the best procedures for controlling the pest on a community basis.

Figure 2.—Distribution of the Japanese beetle through 1947.

DISTRIBUTION OF THE JAPANESE BEETLE

The Japanese beetle was first found near Riverton, N. J., in 1916, having been accidentally introduced from Japan. By the close of 1947 it had spread in all directions over a generally infested area of about 40,000 square miles. (See fig. 2.)

SEASONAL HISTORY, HABITS, AND APPEARANCE OF THE JAPANESE BEETLE

The colored illustration in plate 1 shows how the Japanese beetle looks in its different stages. Its seasonal history is shown in figure 3.

THE BEETLES

The beetles are a little less than half an inch long, and a shiny, metallic green, with coppery-brown wings. You can tell them by the six small patches of white hairs along each side and the back of the body, just under the edges of the wings.

The beetles first appear on their favorite food plants early in the summer. In parts of Virginia they begin to come out about June 1, in

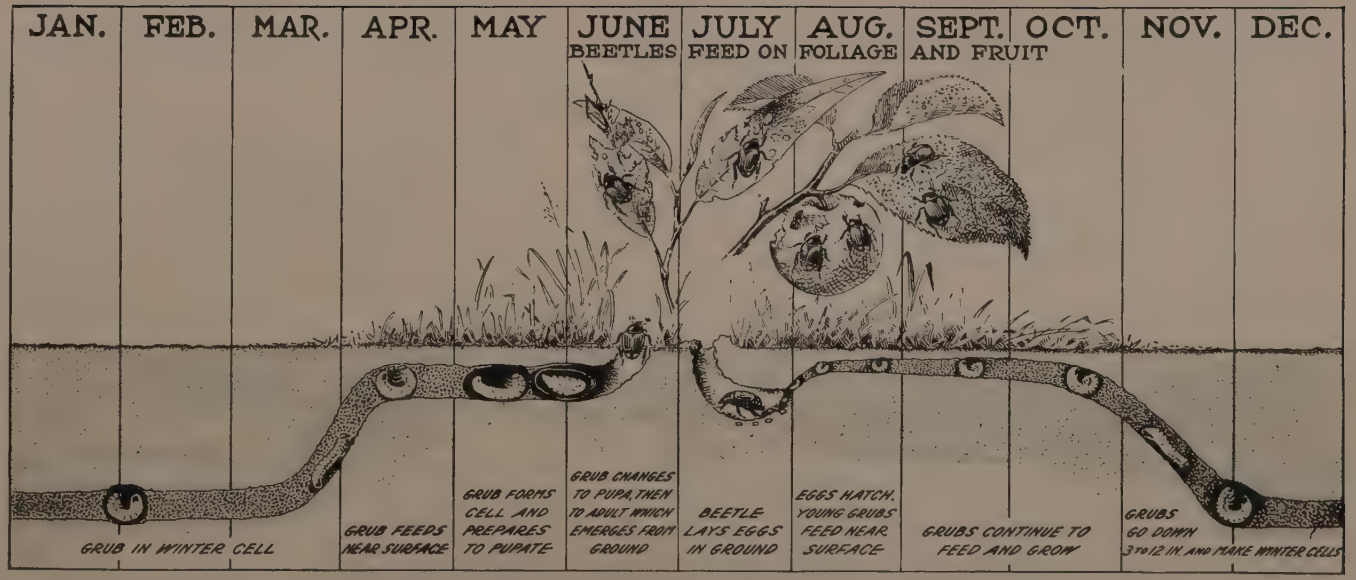

Figure 3.—Seasonal life cycle of the Japanese beetle.

the vicinity of Philadelphia about June 15, and in New England about July 1 or later. Their numbers increase steadily for several weeks, and the period of greatest beetle activity lasts from 4 to 6 weeks. Then they gradually disappear. In Tidewater Virginia most of the beetles are usually gone by the early part of August; in New England they may be fairly numerous until frost.

Japanese beetles fly only in daytime. They are especially active on warm, sunny days. They feed on the parts of plants or trees exposed to the sun. When feeding on leaves they chew out parts between the veins, giving a lacelike appearance to what is left. Injured leaves soon drop. A badly attacked tree or shrub may lose most of its leaves in a short time. A list of many of the more important plants, shrubs, and trees, classified according to whether or not they are subject to feeding is given on pages 4 and 5.

The beetles are especially fond of ripening fruits. They often mass upon such fruits and feed until nothing eatable is left. They do not usually touch unripe fruit. The beetles injure corn seriously by eating the silk as fast as it grows, and keeping the kernels from forming.

THE GRUBS

The grub stage is less conspicuous and less well known. The Japanese beetle spends about 10 months of the year in this stage. From time to time the beetles leave the plants on which they have been feeding, burrow about 3 inches into the ground, usually in turf land, and lay a few eggs.

Figure 4.—Dead turf rolled back, exposing Japanese beetle grubs that have been feeding on the roots.

These eggs soon hatch into tiny white grubs, which feed on the roots of various plants, especially grasses. When numerous, the grubs may cause serious injury to turf (fig. 4). The grubs of the Japanese beetle, although generally smaller, are similar to our native kinds of white grubs. When full grown, the grub is about an inch long (fig. 5). It usually lies in the soil in a curled position.

NATURAL FACTORS LIMITING BEETLE ABUNDANCE

DRY WEATHER

Extremely dry weather during summer kills many of the eggs and newly hatched grubs. Wet summers are favorable to the development of eggs and grubs, and are usually followed by seasons of increased numbers of beetles.

INSECT PARASITES

A number of the more important insect parasites that prey upon this pest have been brought in from Asia. Two of them, the spring Tiphia (fig. 6) from Chosen (Korea) and the fall Tiphia from Japan, have now

Figure 5.—Full-grown Japanese beetle grub. Six times natural size.

become well established in the area first inhabited by the Japanese beetle. These are small, wasplike insects, which can live only on the grubs of the Japanese beetle.

For a number of years the Department of Agriculture, in cooperation with State agencies, has been colonizing the more promising parasites of the Japanese beetle at favorable points throughout the infested areas.

Figure 6.—The spring Tiphia, a wasplike insect parasite that lives on and destroys grubs of the Japanese beetle. Six times natural size.

Thus, over 2,670 colonies had been released in 13 States and the District of Columbia through the year 1947. These enemies of the beetle gradually spread over infested territory where they have become established and become important in the natural control of the beetle. The Department is not in a position to furnish these parasites in response to requests from individuals or local groups.

DISEASES

Japanese beetles and grubs have diseases just as people do. The most important one is caused by tiny germs, or bacteria. It kills many grubs. This disease is called milky disease, because in a diseased grub the blood, which is usually clear, assumes a milky appearance. The milky disease germs, or spores, live in the soil for long periods, ready to infect and kill successive broods of Japanese beetle grubs as they move about in the soil, feeding on plant roots. The disease is fortunately harmless to human beings, warm-blooded animals, and plants.

Department workers have invented devices and methods by which inoculated grubs are used for the production of spores of the milky disease organism in the laboratory. The grubs, after being thus infected, are ground and mixed with talc to form a spore-dust mixture, which can be applied to turf and other ground infested with grubs, to bring about their destruction.

The milky disease occurred only in limited areas in New Jersey and neighboring States when it was first found and studied. In such localities this disease appeared to be an important factor in bringing about a marked reduction in Japanese beetle numbers. However, the spread

of the disease seemed to be lagging behind the spread of the beetle. A program for speeding up the spread of the disease and using the milky disease organism in a practical way to reduce Japanese beetle populations is being carried on by the Department of Agriculture in cooperation with State agencies. This program has been under way since the fall of 1939. More than 90,000 sites had been treated with the milky disease organism in 13 States and the District of Columbia at the close of 1947.

Marked reductions in beetle infestation have already been observed in some of the earliest treated areas, largely because of the rapid development of the disease-producing organism under favorable conditions. It must be expected generally, however, that some time will elapse before a reduction in well-established beetle populations may be observed. In some localities climatic or other conditions may be unfavorable for rapid establishment and development of the disease organism.

The Department does not have spore dust available for distribution to private individuals or organizations, but several individuals or companies have been licensed by the Secretary of Agriculture to manufacture and sell it. The material is thus available for use by individuals or community groups.

OTHER ENEMIES

The numbers of Japanese beetles are sometimes reduced a little by other enemies. Both beetles and grubs are fed upon by several of the more common birds, including starlings and English sparrows. When fields are being plowed, sea gulls and domestic poultry often consume large numbers of grubs. Moles and skunks also feed on the grubs, although often causing considerable injury to lawns in digging for them.

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